

Appl. No. 10/731,496
Amdt. dated December 12, 2006
Reply to Office action of September 29, 2006

APPENDIX

What is Claimed:

2. The drilling tool assembly as defined in claim 16 further including means for rotating said bent portion to a predetermined position.
3. The drilling tool assembly as defined in claim 16, wherein said clutch mechanism is a mechanical clutch which transmits torque using physical contact of surfaces.
4. The system as defined in claim 16, further including a means for transmitting information describing the clock face position of said rotatable housing.
5. The system as defined in claim 16 further including a steering guidance system means within said rotatable housing.
16. A drilling tool assembly comprising:
 - a steering system,
 - a drilling motor,
 - an orienter and ,
 - a drill bit,

Appl. No. 10/731,496
Amdt. dated December 12, 2006
Reply to Office action of September 29, 2006

wherein said drilling motor includes a motor output shaft which provides output power to said drill bit;

wherein said orienter includes a first non-rotatable housing and a second rotatable housing;

wherein said first non-rotatable housing surrounds a clutch mechanism and a speed reduction system;

wherein said clutch mechanism transmits rotary power from said motor output shaft to said speed reduction system, said speed reduction system located between said clutch mechanism and said second rotatable housing;

wherein said second rotatable housing includes a flexible coupling connecting said motor output shaft to an orienter drive shaft which is connected to said drill bit;

wherein said second rotatable housing further includes a bent portion surrounding said orienter drive shaft;

whereby when said clutch mechanism is actuated, rotary power from said motor output shaft is transmitted through said clutch mechanism, through said speed reduction system to rotate said second rotatable housing, while said orienter drive shaft continues to rotate said drill bit.

17. The drilling assembly as defined in claim 16 wherein;

said drilling tool assembly is constructed and arranged for mounting to the end of a length of coil tubing.

18. A method of directional drilling using the assembly of claim 16.

Appl. No. 10/731,496
Amdt. dated December 12, 2006
Reply to Office action of September 29, 2006

DESCRIPTION OF THE EMBODIMENTS

[0023] The orienter **10** of the present invention is attached to the drilling motor assembly **20** portion of a drilling tool assembly **100**. The motor assembly **20** portion is used primarily for turning a rotating drill bit **130**. By repositioning the orienter assembly **10** of the present invention to a different location within the drilling tool assembly **100** than is found in prior art drilling tool assemblies, the construction of the drilling tool assembly is simplified and its overall length is reduced. This simplified construction and reduced length makes a drilling tool assembly **100** incorporating the orienter **10** of the present invention easier to use by eliminating the logistical issues and special job site planning considerations associated with more complex, longer length prior art drilling tool assemblies.

[0024] As may be seen in Figure 1, the orienter **10** of the present invention is used in a drilling tool assembly **100** which is mounted on the end **115** of a length of coiled tubing **110**. The coiled tubing **110** is typically stored on a mobile platform **200** at the earth's surface. An injector assembly **140** connected to the mobile platform **200** grasps the coiled tubing **110** and exerts linear force thereon to move it through a subterranean borehole.

[0025] As may be seen in Figure 2, the disclosed orienter **10** forms a part of a drilling tool assembly **100**. The drilling tool assembly **100** is designed and provided with the necessary hardware well known to those of ordinary skill in the art for mounting on the end of coiled tubing **110**. Beginning at the end **115** of the coiled

Appl. No. 10/731,496
Amdt. dated December 12, 2006
Reply to Office action of September 29, 2006

tubing 110 which connects to the drilling tool assembly 100, the drilling tool assembly 100 includes a steering tool assembly 120 for monitoring and tracking position of the drilling tool assembly 100 in the borehole B as it is being drilled. Mounted next to the steering tool assembly 120 is the drilling motor or mud motor assembly 20. The drilling motor or mud motor assembly 20 is a hydraulic motor which produces rotational power or torque from the flow of drilling fluid or drilling mud through fluid flow passages within the motor assembly 20. It is typically the motor assembly 20 which adds the greatest amount of length to the drilling tool assembly 100.

[0026] According to the present invention, the orienter assembly 10 of the present invention is positioned in front of the drilling motor assembly 20, just behind the rotating drill bit 130. The orienter assembly 10 includes a housing 30 which may be divided into an upper section 32 and a lower rotatable section 34. Finally, at the distal end 102 of the drilling tool assembly 100 is the rotating drill bit 130. It is the rotating drill bit 130 which actually cuts through the soils and the rock to form the subterranean borehole B. Linear force transmitted to the drilling tool assembly 100 by the force placed on the coiled tubing 110 by the injector assembly 140. The linear force moves the rotating drill bit 130 forward as the rotating drill bit 130 cuts through the soil and rock at the drill face at the end of the borehole.

[0027] In Figure 2 the lower rotatable section 34 is held fast; that is, it does not rotate. Accordingly, the fixed bend 36 in the lower rotatable section 34 of the orienter 10 causes the rotating drill bit 130 to form an arcuate segment of the borehole B. As shown in exaggerated manner in Figure 2, if the fixed bend 36 is in a substantially

Appl. No. 10/731,496
Amdt. dated December 12, 2006
Reply to Office action of September 29, 2006

vertical plane, the drilling tool assembly 100 will form an arcuate segment of the borehole B which tracks upwardly to the earth's surface S, thereby allowing for removal of the drilling tool assembly 100 from the end 115 of the coiled tubing 110 after the drilling tool assembly 100 exits the borehole.

[0028] In contrast, the lower rotatable section 34, shown in Figure 3 is not held fast or in a fixed position; instead it is allowed to turn. The turning of the lower rotatable section 34, to include both the fixed bend 36, and the lower portion 34, with respect to the non-rotary housing 22 around the drilling motor 20, enables the rotating drill bit 130 to cut a straight line segment of a large borehole. The transfer of torque from the drive shaft 24 portion of the drilling motor assembly 20 to the upper section 32 causes the entire lower rotatable section 34 to turn as shown in Figure 3.

[0029] In a macro sense, the housing 30 of the disclosed orienter 10 looks like an extension of the non-rotating housing 22 which surrounds the drill motor 20. However, housing 30 of the orienter 10 is separate from housing 22. This separation allows the external, lower rotatable section 34 with a fixed bend 36 to rotate constantly at a minimal rpm while the drill motor assembly 20 causes the rotating drill bit 130 to move straight ahead with an oscillating action and thereby form a straight segment of the borehole B, as shown in Figure 3. Disengagement of the mechanical connection between the upper section 32 from the drive shaft 24 portion of the drill motor assembly 20 and the indexing of the lower rotatable section 34 to the desired clock face position has the effect of placing the rotating drill bit 130 in a directional or

Appl. No. 10/731,496
Amdt. dated December 12, 2006
Reply to Office action of September 29, 2006

steering mode as shown in Figure 2 because the fixed bend 36 in the external, lower rotatable section 34 does not rotate. However, because the drive shaft 24 of the drilling motor 20 is still connected to the rotating drill bit 130 by a universal joint or flexible coupling 26, and thusly, the orienter drive shaft 27, the rotating drill bit continues to turn.

[0030] As shown in Figure 4, the necessary drive force or rotational torque which causes the external, lower rotatable section 34 with a fixed bend 36 to turn is obtained from the drive shaft 24 of the drill motor assembly 20. In the preferred embodiment, connection of the external, lower rotatable section 34 with a fixed bend 36 to the drive shaft 24 of the drill motor 20 is accomplished by the use of a mechanical clutch mechanism 40.

[0031] The clutch mechanism 40 may be activated by a variety of different means to include an electrical, hydraulic, or mechanical signal. In the illustrated embodiment, the mechanical clutch mechanism 40 includes a first rotating tapered or wedge section 42 with an internal contact surface 44 which frictionally engages a second rotating tapered or wedge section 46 with an external contact surface 48. The frictional contact between internal surface 44 and the external contact surface 48 is sufficient to transmit rotational torque from the drive shaft 24 to the internal gear assembly 60. Those of ordinary skill in the art will understand that other types of mechanical clutch mechanisms or non-mechanical clutch mechanisms may be used without departing from the present invention. Such other clutch mechanisms may include electrical clutches and hydraulic clutches.

Appl. No. 10/731,496
Amdt. dated December 12, 2006
Reply to Office action of September 29, 2006

[0032] In the preferred embodiment, an internal gear assembly 60 within the upper section 32 is used. The internal gear assembly 60 includes a plurality of externally toothed spur gears 62. The rotation of the spur gears 62 causes rotation of the external housing 30 by engagement of a large-internally toothed ring gear 64 with the rotating spur gears 62. The gear ratio between the spur gears 62 and the ring gear 64 provides for a reduction in speed and an increase in torque. The end result is a circular movement of the lower rotatable section 34 including the fixed bend 36 and the rotating drill bit 130 to drill a straight borehole through soil and rocks. Those of ordinary skill in the art will understand that while a simple speed reduction gear train has been shown in the preferred embodiment, other speed reducing or torque mechanisms may be used without departing from the scope of the invention, to include but not limited to a hydraulic drive or a helical actuator.

[0033] To assure proper clock face position of the lower rotatable section 34 with respect to the non-rotating housing 22 surrounding the motor assembly 20 or torque transfer, a set of radially spaced contact points or similar radial position indicating systems, well known to those of ordinary skill in the art, may be used to provide a signal representative of the clock position of the lower rotatable section 34. As the lower rotatable section 34 is selectively rotated or indexed to a desired orientation by the motor 20, a single contact closes a circuit at a location representative of the clock face position of the lower rotatable section 34. The signal is received at the surface using a wireless transmission or a wire line. Knowledge of the clock face position of the lower rotatable section 34 enables the operator to assure that the fixed

Appl. No. 10/731,496
Amdt. dated December 12, 2006
Reply to Office action of September 29, 2006

bend portion 36 of the orienter 10 is properly rotated or indexed to the desired orientation to create an arcuate segment of the borehole B which follows along a predetermined path.

Operation

[0034] A still better understanding of the orienter of the present invention may be had by an understanding of its method of operation.

[0035] The system and method of the present invention is part of a drilling tool assembly 100 which typically governs the operation and direction of a rotating drill bit 130. As distinguished from prior art orienters, the orienter 10 is positioned next to the rotating drill bit 130. The combination of the drill bit 130, the orienter 10, and the mud motor assembly 20 is located on the end 115 of coiled tubing 110. Because the orienter 10 has been relocated to a position next to the rotating drill bit 130, it is now in a position where it can use the torque output of the mud motor assembly 20 rather than rely on a separate source of torque or rotary power. Those of ordinary skill in the art will also understand that while the conventional location for the steering tool assembly 120 which provides an indication of tool 100 location behind the motor assembly may be used, a steering tool assembly 150 may also be located inside of the lower rotatable section 34 or ahead of the mud motor assembly 20 as shown in Figure 5

[0036] The orienter 10 of the present invention may be used with its own indicators to provide position information if necessary or desired. Specifically, the disclosed orienter 10 will be capable of including a radio beacon transmitter 50 for

Appl. No. 10/731,496
Amdt. dated December 12, 2006
Reply to Office action of September 29, 2006

wireless or wireline reporting of the position and orientation of the lower rotatable section 34.

[0037] Also, as previously indicated, the disclosed system and method allows for the orienter 10 to be placed ahead of or in front of the mud motor assembly 20. This arrangement simplifies construction and provides easier set up of drilling operations. In addition, this configuration enables the torque provided by the drilling motor 20 to both rotate the lower rotatable section 34 including the fixed bend 36 for either drilling a straight line portion of the borehole B or for rotating the housing to a desired clock face position for drilling an arcuate portion of the borehole B.

[0038] The preferred embodiment of the orienter 10 includes the use of a gear reduction system 60 driven by the output driveshaft 24 of the mud motor assembly 20 to both change the rotary speed and torque provided. The output driveshaft 24 of the mud motor assembly 20, when engaged with the housing 30, rotates the lower rotatable section 34 that contains the fixed bend 36. When desired, the gear reduction system 60 is disengaged from the output driveshaft 24 of the mud motor assembly 20 to cause the rotating drill bit 130 to create an arcuate borehole in a predetermined direction. The gear reduction system 60 can then be re-engaged to provide continuous rotation of the lower rotatable section 34, thereby facilitating drilling a straight segment of the borehole as shown in Figure 3.

[0039] Observers of the entire system will see a large storage and spooling reel 108 containing a sufficient length of a continuous coiled tubing 110 to be injected and

Appl. No. 10/731,496
Amdt. dated December 12, 2006
Reply to Office action of September 29, 2006

retracted from the borehole as shown in Figure 1. The coiled tubing **110** is coupled to the storage and spooling reel **108**. The spooling reel **108** contains a fluid swivel at its center portion to allow fluids to be pumped through the coiled tubing **110**. An electrical wire, for communication of an electrical control signal or providing electrical power, may be inserted through the entire length of the coiled tubing **110** to provide access at the storage and spooling reel **108** for coupling to controls at the earth's surface using an electric swivel. The coiled tubing **110** is injected and retracted (pushed/pulled) by an injector assembly **140** that grasps the coiled tubing **110** and moves it in the desired direction.

[0040] The housing **22** containing the drill motor **20** itself does not contain a fixed bend section. Specifically, the drill motor assembly **20** is a straight mud motor known as a positive displacement motor or "monyo" style motor. The drill motor housing **22** abuts the leading end **115** of the coiled tubing **110** and is held in place by the coiled tubing **110** which resists the torque and tensile forces involved in the drilling process.

[0041] Typically, control of the orienter **10** requires communication of an electrical signal. This communication and any power required to actuate the clutch mechanism may be provided by an electrical wireline connection and pathway provided within the entire system. This pathway may either be fully inside the coiled tubing **110** and drilling tool assembly **100** or maintained on the outside of the coiled tubing **110** and drilling tool assembly **100**.

Appl. No. 10/731,496
Amdt. dated December 12, 2006
Reply to Office action of September 29, 2006

[0042] Alternatively, wireless means may be used for control of the operation of the orienter 10. When a wireless control system is used, a transmitter and receiver may be used to communicate with each other, providing instructions for when to engage and disengage (rotate or go steer) the orienter 10. Such instruction can be implemented by installing a logic assembly in the orienter 10 that receives and sends data back and forth to a transmitter/receiver that is located in the coiled tubing 110 at the leading end of the tubing 105, above the mud motor 20.

[0043] Once the rotating drill bit 130 exits the ground, only the orienter portion 10 of the drilling tool assembly 100 need be pushed further out of the ground. If a back reaming tool powered by the mud motor is to be pulled back through the borehole, only the orienter 10 need be removed from the front of the mud motor assembly 20 to attach the back reamer.

[0044] Critical to the operation of the orienter 10 of the present invention is the amount of torque that is generated by the speed reduction or torque conversion system. In the preferred embodiment, the torque transferred by the internal gear reduction system 60 is determined by the design parameters of the gears 62, 64. To minimize the effect of torque on the gears 62, 64, two functions have been incorporated into the orienter 10. The first function is a built-in slip in the frictional power transfer engagement of the clutch mechanism 40. This built-in slip releases the drive shaft 24 at a given amount of excess torque to prevent damage. The second function is the basic design of the housing. Although it is imperative that the housing be robust enough to withstand the forces and the conditions encountered when drilling a borehole, the

Appl. No. 10/731,496
Amdt. dated December 12, 2006
Reply to Office action of September 29, 2006

housing has also been designed to minimize the amount of resistance against the sides of the borehole to prevent a potential lag – which potential lag would be seen as increased torque load in the gear section.

[0045] While the present system and method has been disclosed according to the preferred embodiment of the invention, those of ordinary skill in the art will understand that other embodiments have also been enabled. Such other embodiments shall fall within the scope and meaning of the appended claims.